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Publication date:
2018

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Andrade de Sá, S., Thomsen, M. N., Yu, W., & Schou, J. S., (2018). *Note on the possibilities for quantifying agricultural production shifts associated with EU ESD targets for 2021-2030*, 8 p., IFRO Commissioned Work, No. 2017/15

DEPARTMENT OF FOOD AND RESOURCE ECONOMICS
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IFRO Commissioned Work

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2017 / 15

IFRO Commissioned Work 2017/15

(IFRO Udredning 2017/15)

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Published February 2018

This publication has been prepared in connection with a project supported by the Danish Ministry of Food and Environment. A technical paper, “GHG mitigation in the agricultural sector: Comparing the GAINS and Danish methodology and data”, is published separately as IFRO Documentation 2017/8.

Find the full series IFRO Commissioned Work (mostly in Danish) here:
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December 12, 2017

Note on the possibilities for quantifying agricultural production shifts associated with EU ESD targets for 2021-2030[1]

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Summary

In this paper we investigate the possibilities for doing a comprehensive CGE based economic analysis of how complying with the EU Effort Sharing Decision of the targets set for the period 2021-2030 for the sectors outside the GHG quota system may affect agricultural production and trade, not only in Denmark but in all EU-28 member states. The analysis revealed that results from the scenarios designed using the data from the GAINS model had some properties that led to counter-intuitive changes in production and trade patterns across the EU. This was especially due to questions raised regarding the marginal abatement costs of reducing GHG emissions from agricultural sectors in the different countries. Therefore, it was decided not to move further with the CGE analysis.

Introduction

New GHG (GreenHouse Gas) emissions targets are to be set by the EU Commission under the ESD[2] for the period 2021-2030. As for the previous resolution, these targets concern the main GHG emitting sectors not included in the ETS[3] system: agriculture, transport, waste and heating.

Different targets have been set for the EU countries based on GDP per capita and taking into account cost-effectiveness. Although the modalities are not entirely set – and negotiations are still ongoing – a general target of 39 per cent emissions reduction (compared to 2005 levels) has been suggested for

[1] This project is supported by the Danish Ministry of Food and Environment. During the work scenarios and results has been discussed in a reference group with Signe Anthon (MFVM), Mathias Borritz Milfeldt (MFVM), Henrik Jepsen (MFVM) and Thøger Lund-Sørensen (MFVM). All responsibilities for the results remain with the authors alone.

[2] Effort Sharing Decision.

[3] ETS: Emissions Trading System.

Denmark. As a comparison, the Danish target for the 2013-2020 period was a 20 per cent emissions reduction (compared to 2005 levels).

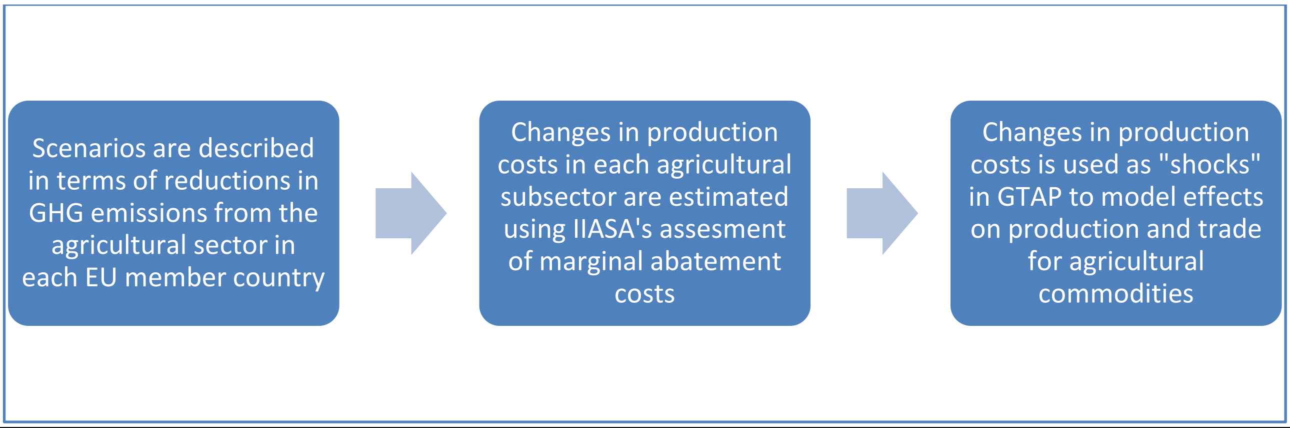
In this report, we investigate the possibilities for doing a comprehensive CGE based economic analysis of the effects on agricultural production and trade of complying with the ESD 2030 targets suggested by the EU Commission.

Methodology and Data

To develop policy relevant scenarios, a review of the literature of relevant measures and policies for GHG reductions in the agricultural sector across EU countries is initially performed, that is evaluating the options for mitigating GHS emissions in various countries taking into account the variations in marginal abatement costs. The International Institute of Applied Systems Analysis (IIASA) could provide this information in terms of the GAINS model[4] (Höglund-Isaksson et al., 2016). Data on abatement costs and abatement potential for the agricultural sector in each EU member state can then be used for designing policy shocks to be implemented in the CGE[5] model GTAP[6]. This enables us to evaluate the effects of different approaches to implementing the targets in the non-ETS sectors on agricultural production in the EU – and Denmark in particular.

Figure 1 illustrates the steps of the proposed steps in the analysis. In the following, we will elaborate further on the methodology.

Figure 1. Steps of the analysis



The GTAP model

[4] GAINS: Greenhouse Gas and Air Pollution Interactions and Synergies.
[5] CGE: Computable General Equilibrium.
[6] GTAP: Global Trade Analysis Project.

The motor of the analysis is the GTAP model, a multiregion, multisector, computable general equilibrium model, with perfect competition and constant returns to scale. The model was developed to quantify effects on production, consumption and trade of commodities – including agricultural commodities that are subject to policy changes. In particular, the GTAP model and its associated database provide input-output linkages across different agricultural sectors and between agriculture and the rest of the economy (Brockmeier, 1996). The model and database cover individual EU member states – as well as virtually all the important economies outside of the EU. The model is therefore able to assess effects spanning beyond the EU region. Through bilateral trade linkages at sectoral levels, GTAP can also trace through the transborder effects of assumed shocks, thereby enabling the model to capture potential leakages associated with simulated changes in production and trade patterns. Data is the information source that combines diverse elements into consistent snapshots of the global economy. GTAP have high barriers to entry according to data and software. The database is updated annually and is increasingly used on climate change policy.

The IIASA data

To analyse our policy changes (or "shocks") in GTAP, we have used data from the GAINS model kindly provided to us by the International Institute of Applied Systems Analysis (IIASA) encompassing abatement costs and abatement potential for the agricultural sector in each EU member state (Höglund-Isaksson et al., 2016).[7]

At the core of GAINS is an optimization procedure finding optimal cost-efficient solutions for emission reductions. For each pollutant and country, cost curves are constructed where the different emission reduction technologies are ranked according to their per unit abatement costs, and hereby a marginal abatement cost curve (MAC curve) is approximated. Then using the MAC curve, a cost minimizing strategy is developed by using cost-efficient technologies first until the accumulated emissions reductions correspond to the policy target. GAINS adopts a private (that is, industry) perspective. The mitigation costs obtained are therefore those that would meet the agricultural sector agents.[8] In IFRO

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[7] IIASA has granted IFRO the right to extract and use the dataset "Marginal abatement cost curve for non-CO2 GHGs in EU-28 agricultural sector for year 2030" to be used in the project "The impacts of regulating GHG emissions in the Danish agricultural sector". The data remains the property of IIASA, and IFRO cannot publicize the IIASA data or forward the data to a third party. IFRO acknowledges IIASA as source and data owner.

[8] In contrast, Danish authorities use a different approach: The Catalogue of Danish Climate Change Mitigation Measures (Inter-ministerial working group, 2013), is based on a welfare economic method, which is in line with the guidelines on welfare economic analysis from the Danish Ministry of Finance. In particular, it focuses on computing a Social Shadow Cost of Carbon. It is therefore a "social" perspective that is adopted (rather than a private one as in GAINS). The report states: "The shadow price for a given mitigation measure expresses the welfare economic costs and benefits of reducing greenhouse gas emissions by one ton of CO2 equivalent. This makes it possible, by comparing the shadow prices for the measures, to obtain an overall assessment of the most cost-effective mitigation measure from a welfare economic perspective."

Documentation 2017/8, we describe the method and assumptions in the GAINS model and compare it to the work of Danish GHG mitigation costs form agriculture by Dubgaard et al. (2013).

The mitigation potential assessed in the GAINS model refers to feasible reductions in emissions through adoption of mitigation technologies defined as installations or applications of physical equipment or material or modifications in physical parameters affecting emissions. Non-technical mitigation options that involve changes in human behaviour and preferences, for example changes in human diets towards consumption of less meat and milk products, are excluded from the analysis. In GAINS, mitigation costs per unit of activity are calculated as the sum of investment costs, labour costs, non-labour operation and maintenance costs, cost-savings due to recovery or saving of electricity, heat or gas, and non-energy cost savings.

In regards to the specific mitigation measures, the GAINS model considers the following ones, which generally apply to all member states, although with different mitigation potential in each country:

- Abandoning of agricultural use of organic soils
- Ban of open burning of agricultural waste
- Breeding through selection to enhance feed efficiency
- Farm-scale anaerobic digestion
- Feed additives and/or changed feed management practices
- Intermittent aeration, alternative hybrids and sulphate amendments
- Nitrification inhibitors
- Precision farming
- Variable rate technology (better timing of fertilization).

Table 1 below summarizes the total annual abatement cost and total GHG abatement in the agricultural sector of each country, if all mitigation measures in the model were to be implemented to their full potential.

What does not show from the table, is that a number of measures are assumed to have zero marginal abatement costs and, further, for some measures, large differences are seen for the abatement costs in different countries. For instance, in the GAINS estimation of CH4 mitigation costs, energy recovery from biogas production or reduced leakage of natural gas during production, transmission and distribution is valued at the electricity or gas consumer price. This implies that implementing farm-scale anaerobic digestion, which allows farmers to sell biogas, should be feasible at no cost for farmers with farms with more than 100 Livestock Units, which seem to be a rather optimistic assumption (see for example Jacobsen et al. 2014).

Table 1. Mitigation costs and abatement potential in agriculture – GAINS

Country	Total annual mitigation costs (million euros)	Total abatement (Kt CO2 equiv)	Average cost (million euros) per Kt CO2 avoided
AUST	136.9	963	0.142
BELG	278.6	2,896	0.096
BULG	159.5	1,566	0.102
CROA	71	643	0.110
CYPR	6.6	187	0.035
CZRE	195.15	1,764	0.111
DENM	**242.8**	**3,530**	**0.069**
ESTO	39.9	386	0.103
FINL	276.4	2,114	0.131
FRAN	2,434.7	16,974	0.143
GERM	2,080.8	18,179	0,114
GREE	119.3	1,242	0.096
HUNG	201.1	1,934	0.104
IREL	513	4,591	0.112
ITAL	583.3	6,315	0.092
LATV	104.8	814	0.129
LITH	286	2,345	0.122
LUXE	20.5	134	0.153
MALT	1.4	14	0.100
NETH	638.6	5,577	0.115
POLA	1,091.1	9,050	0.121
PORT	119.3	1,951	0.061
ROMA	290.7	3,150	0.092
SKRE	77	653	0.118
SLOV	23.8	177	0.134
SPAI	625.7	12,829	0.049
SWED	286.9	1,901	0.151
UNKI	724.5	10,332	0.070

Note: The table shows total annual abatement cost and total GHG abatement in the agricultural sector of each country, if all mitigation measures in the GAINS model are implemented to their full potential.

Source: Own calculations based on Höglund-Isaksson et al. (2016).

Another thing is that for a number of other measures, the MAC is equal in all EU countries. This seems questionable due to known differences in for example labour costs and farm productivity. One example of equal MAC in all EU countries is the measure “abandoning agricultural use of organic soils”. Intuitively this seems highly unexpected as it implies that the Ricardian land rent from agricultural activities on organic soils should be uniform across EU countries (or that the GHG emissions reductions varies between countries in such a way that it outweighs the differences in land rent). Another example is “precision farming”, where MAC is given for three farm sizes but with no differences between countries. For this measure, it is also notable, that it was left out of the Danish catalogue of measures (Dubgaard, 2013) because of difficulties related to defining the effects unambiguously.

The EcAMPA 2 study

The analytical question of the structural effects of GHG targets has previously been addressed in a study commissioned by the Joint Research Center report on mitigation efforts for the European agricultural sector (Pérez Domínguez et al., 2016) – also called the EcAMPA 2 study. The main results from the EcAMPA 2 study are that European agricultural production is negatively affected by the imposition of unilateral GHG mitigation targets to EU member states. Regarding Denmark, the results from the EcAMPA 2 study show production decreases ranging from 5.9 per cent to 16.1 per cent in beef production (tons); 1.4 per cent to 4.1 per cent in milk production; 0.2 per cent to 5 per cent in pork production; but an increase from 0.8 per cent to 3.1 per cent in the cereal area.

However, there are a number of critical choices made in the EcAMPA 2 study. Some of these choices reflect basic assumptions for the scenarios, which differ from the proposal put forward by the EU Commission, and some relate to adjustments made to the abatement costs in the GAINS model.

In the EcAMPA 2 study, the mitigation policy scenario departs from an overall reduction of agricultural GHG emissions in the EU-28 of 20 per cent in 2030 compared with 2005. The overall target is allocated into targets per member state following a “cost-effective” allocation of mitigation efforts. This method results in mitigation targets for each member state that are rather different from the ESD targets announced by the Commission.[9] In particular, the targets considered in the EcAMPA 2 study tend to be much lower for the EU-15 member states (including Denmark), while they are substantially higher for the EU-N13 countries. The main reason for the discrepancy between the country targets in the

[9] In reality, as explained earlier, the ESD sets an overall target for all non-ETS sectors of each member state, which then have to decide how much of that target is to be satisfied by mitigation efforts within the agricultural sector.

EcAMPA 2 study and the proposal by the Commission is differences in the abatement costs across measures and countries.

Further, although the EcAMPA 2 study also relies on the GAINS model, the mitigation costs are adjusted by adding “other costs not accounted for in that database” (Pérez Domínguez et al., 2016). These “other costs” are motivated by the fact that the GAINS abatement costs disregard the implementation costs at the farm level. Thus, to overcome the costs of adoption of new technologies, it is assumed that farmers will need to receive subsidies that vary between 80 and 120 per cent of the marginal cost of a given technology. It is clear that this substantially adds to the costs of the GAINS model, and thus must implicitly be seem as a criticism of the GAINS model. On the other hand, the corrections of the cost estimates in the EcAMPA 2 study also lack documentation, which makes it difficult to validate these as well.

Finally, the EcAMPA 2 study relies on the Common Agricultural Policy Regional Impact[10] model, which is a Partial Equilibrium model focusing on the agricultural sector. Thus, the model ignores the linkages between agricultural sectors and the rest of the economy that would be captured if using a CGE approach such at the GTAP. The differences in the two modelling approaches tend to pull in a direction where the effects of a given policy shock will be higher using the CAPRI model compared to the GTAP model, and it would be interesting to investigate the impact of these differences in debt in a policy analysis context.

Discussion and conclusions

The aim of this work was to investigate the possibilities for doing a comprehensive CGE based economic analysis of the changes in agricultural production and trade of the EU ESD targets set for the period 2021-2030, not only in Denmark but in all EU-28 member states..

To develop policy relevant scenarios, the analysis departs from evaluating the costs of mitigating GHS emissions in various countries. Data on abatement costs and abatement potentials for the agricultural sector in each EU member state was retrieved from the International Institute for Applied Spatial Analysis (IIASA), the so-called GAINS model. Thereby we use the same data as used by the EU Commission.

Preliminary results from the GTAP analysis showed that the scenarios designed using the GAINS model had some properties that led to counter-intuitive changes in production and trade patterns across the EU countries. This was especially due to questions raised regarding the marginal abatement

[10] CAPRI: Common Agricultural Policy Regional Impact.

costs of reducing GHG emissions from agricultural sectors in the different countries. Especially, problems stem from the fact that some sectors had nominal values of zero for the marginal abatement costs, and that these estimates could not be verified by other sources. Thus, compared to existing partial Danish estimates of marginal abatement costs (Dubgaard et al., 2013), it seem that the GAINS estimates are very conservative. For this reason, we decided not to move further with the CGE analysis.

Thus, the insights from this work reveal that there is a need for developing a consistent analytical framework for assessing economic costs and changes in production and trade at the EU level resulting from GHG targets in the non-ETS sectors. The work has revealed some questionable issues relating to the GAINS cost data and more generally to the transparency of the data and studies that form the basis of the new GHG emissions targets suggested by the European Commission under the Effort Sharing Regulation for the period 2021-2030. The models for analysing the structural changes in agricultural production and trade are available, but further work needs to be done in order to estimate and validate the abatement costs of GHG measures in the agricultural sector consistently across countries. Consolidated abatement cost estimates will enable the building of consistent scenarios with a clear interpretation from the farm level to the aggregated level.

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